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SIMPLE KNIT DESIGN SYSTEM; USING PATTERN MATCHING

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ABSTRACT

We describe a system that interactively generates stitch symbol and string diagram of knit pattern. A collection of grid data is inputted through a GUI. These grid data are then converted to a set of stitch symbols and string diagram in turn. The system implements sets of rule for converting grid data to stitch symbol and uses set of crossing model for representing and topological movement for processing string diagram.

KEY WORDS: Computer Aided Design, Graphical Modeling, Image and Pattern Analysis, Intelligent User Interface.

1. INTRODUCTION

Knitting [1] has long been the favorite technique for sweater making because of the detailing and color patterning that is possible, and the supple, drapable fabric the stitches produce. The two basic stitches--knit and purl--can be worked alone or together and form the basis of dozens of designs as well as other stitches. Knitting requires two needles and a continuous strand of yarn. The basic stitches are created using both needles, wrapping the yarn over one needle and drawing the wrapped yarn through loops on the other needle (See Fig.1).

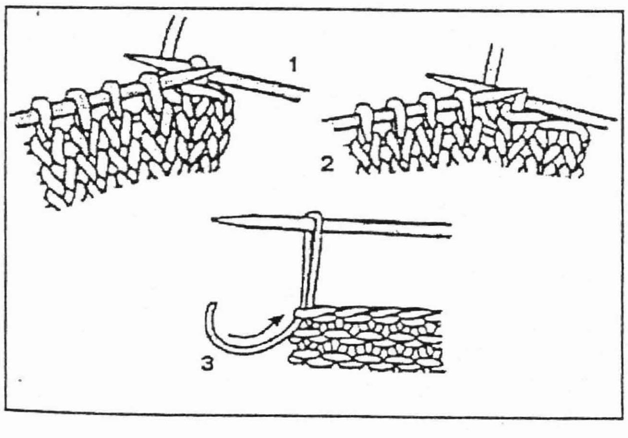

Fig.1 Knitting

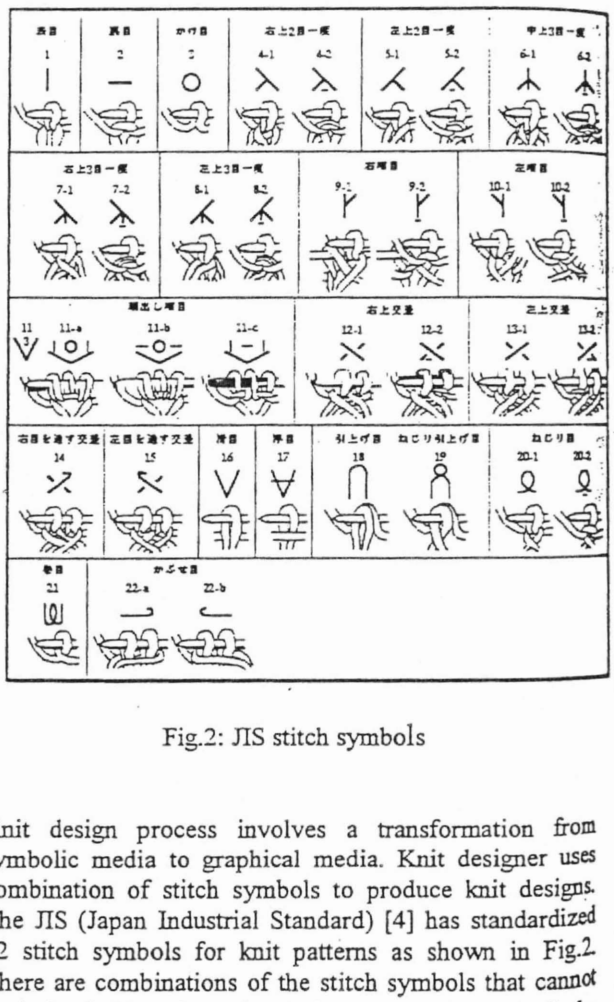

Fig.2: JIS stitch symbols

Knit design process involves a transformation from symbolic media to graphical media. Knit designer uses combination of stitch symbols to produce knit designs. The JIS (Japan Industrial Standard) [4] has standardized 22 stitch symbols for knit patterns as shown in Fig.2. There are combinations of the stitch symbols that cannot be knitted. Therefore, the designer must know well the stitch symbol. However, we can construct rules to compose knittable design, which is based on the knowledge of possible combinations of stitch symbols.

This paper attempts to provide a system to help a novel designer to make a knittable design. Our system also aims to provide a user-friendliness, in which the user does not need to know detail of stitch symbols. Our system will convert the inputted design in grid format to an appropriate stitch symbols composition, based on predefined rules. Thus, the paper will contribute on the

Algorithm 2:

1. For each row of grid data
2. Scan the row data
3. Change all grid data '12' to '45'
4. Change all grid data '500…04' to '300…01'
5. Change all grid data '400…05' to '100…02'
6. Perform the rules 1,2,3, 4,5 and 6 of Table 2 in sequence.
7. End

Algorithm 3:

1. For each row of grid data
2. Scan the row data
3. Change all grid data '12' to '45'
4. Change all grid data '5xx…x4' to '3xx…x1'
5. Change all grid data '4xx…x5' to '1xx…x2'
6. Perform the rules 1,2,3, 4,5 and 6 of Table 2 in sequence.
7. End

where x is '0', '2', or '3'.
Algorithm 2 handles two or more holes, which only have space in between, whereas, algorithm 3 handles two or more holes, which have space or edge in between.

3. STRING PROCESSING

We review the string model and string processing method proposed by Itoh [2]. The model of string called as string diagram is shown in Fig.3. String diagram consists of a set of crossing points, edges, and their connections.

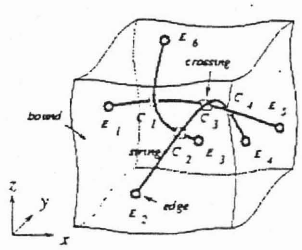

Fig.3: String Object Representation

Itoh [2] and Yamada [3] proposed crossing movements to generate a stable string diagram. The stable string diagram has minimum total length of the string.

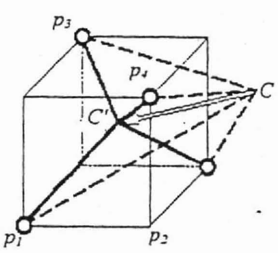

Fig.4: Geometrical Movement.

By placing crossing points in their proper coordinates, we obtain the stable diagram. The movements involve the Reidemeister movements and the geometrical movement shown in Fig.4.

The stitch symbol composition is transformed to string diagram. A database is used to keep a relation between stitch symbols design and their appropriate knittable string diagrams. Fig.5 illustrates some entries inside the database. By matching the stitch symbol components to the database entries we can obtain the string diagram of inputted knit design

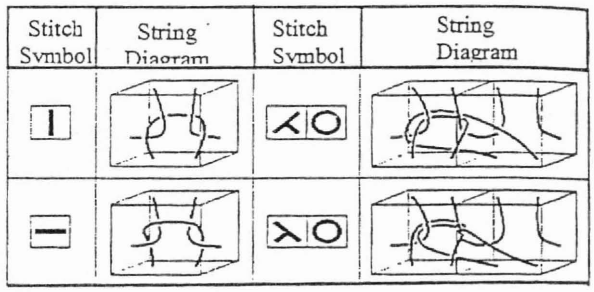

Fig.5 Stitch-String database.

4. IMPLEMENTATION

The system has a GUI for composing a knit design. User can choose to use grid media or to compose the design with the stitch symbols media directly. In the grid media mode, user composes a pattern by determining the boundary (edge) of the pattern and the holes if any. We use different colors to distinguish boundary from holes. Fig.6 shows a *leaf* pattern with two holes on the grid media. The border (edge) of the leaf indicated by blue grids, whereas red grids indicate holes.

The implementation model is shown in Fig.7. The system has five components: GUI, Media Transformer, String Diagram Generator, Stable Diagram Generator, and Viewer.

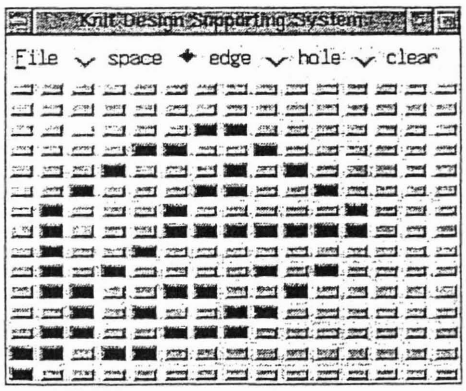

Fig.6: Leaf pattern on the grid media.

The Media Transformer converts the grid data to the stitch symbol media by executing the algorithms described in Section 2. By referring the database, String Diagram Generator will transform the stitch symbol into string diagram or other formats (bitmap, ASCII, etc.). The string diagram is then processed by the Stable Diagram Generator to obtain the stable diagram. Finally, the Viewer component renders the string diagram and displays the complete image of the knit design on the screen. Our rendering system relies on a baseline ray tracing system. If the user does not satisfy with the design he or she can modify the grid or the stitch symbol media, and the system will refine the design.

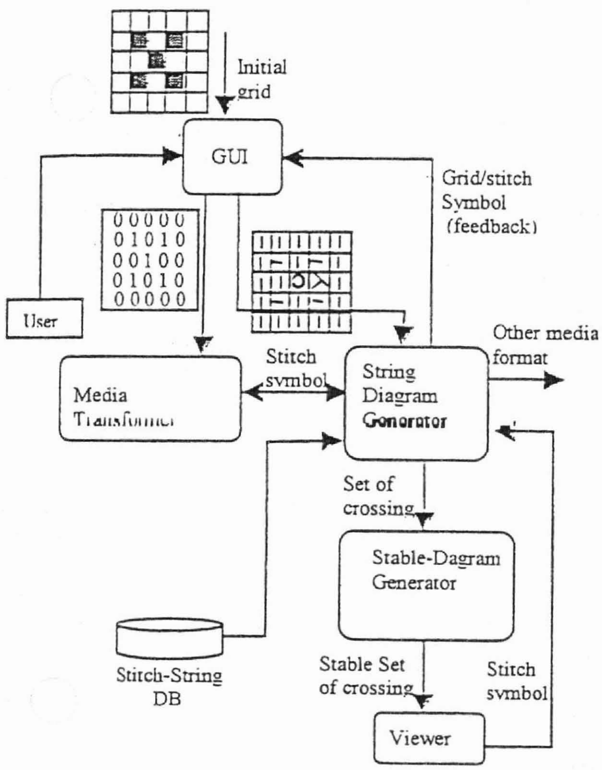

Fig.7: Implementation Model.

5. RESULTS AND DISCUSSION

We ran simulations in Fig.8 by using algorithm 2 and algorithm 3. The first row shows the grid data input. The second and fourth rows show the stitch symbol produced by algorithm 2 and algorithm 3, respectively. The third and fifth rows are knit design patterns generated by algorithm 2 and algorithm 3 for each inputted grid data. The first column is basic pattern of the knit (called as *space*). The second and the third column show patterns that consist of some holes. The last column shows how the system provides the easy way to modify design from the pattern in the previous column.

From the running examples we figure out that algorithm 3 produces clearer knit patterns, since it handles carefully the hole-edge combination in a row. Algorithm 3 gives clear boundaries (edges) of the holes.

Finally, we found that our system performance is in reasonable delay time (3 to 4 seconds) for generating the worst case knit design pattern. We determine the worst-case pattern as a pattern that has crossless-stitch ratio about 20%. The crossless-stitch ratio is a ratio of the number of stitch symbol O to the whole stitch symbols in a knit pattern and it measures the complexity of the knit pattern. Hence, we can recommend the implementation of a real time system for knit design.

6. CONCLUSION

In this paper, we proposed a method to extend set-of-crossing-point-based modeling to deal with producing image of string object in 3-D. The input to the system is a grid pattern. As part of this system, we introduced the rules for converting grid symbol to stitch symbol of knit pattern using regular expressions. Through running some examples, we found that the system can generate a correct and proper stitch symbols from a grid data, and display its string image of knit pattern.

For more complex patterns of knit, such as color patterns that use color strands, we need some new rules and algorithms. Furthermore, we consider the vertical relation between stitch symbols as our future work as well.

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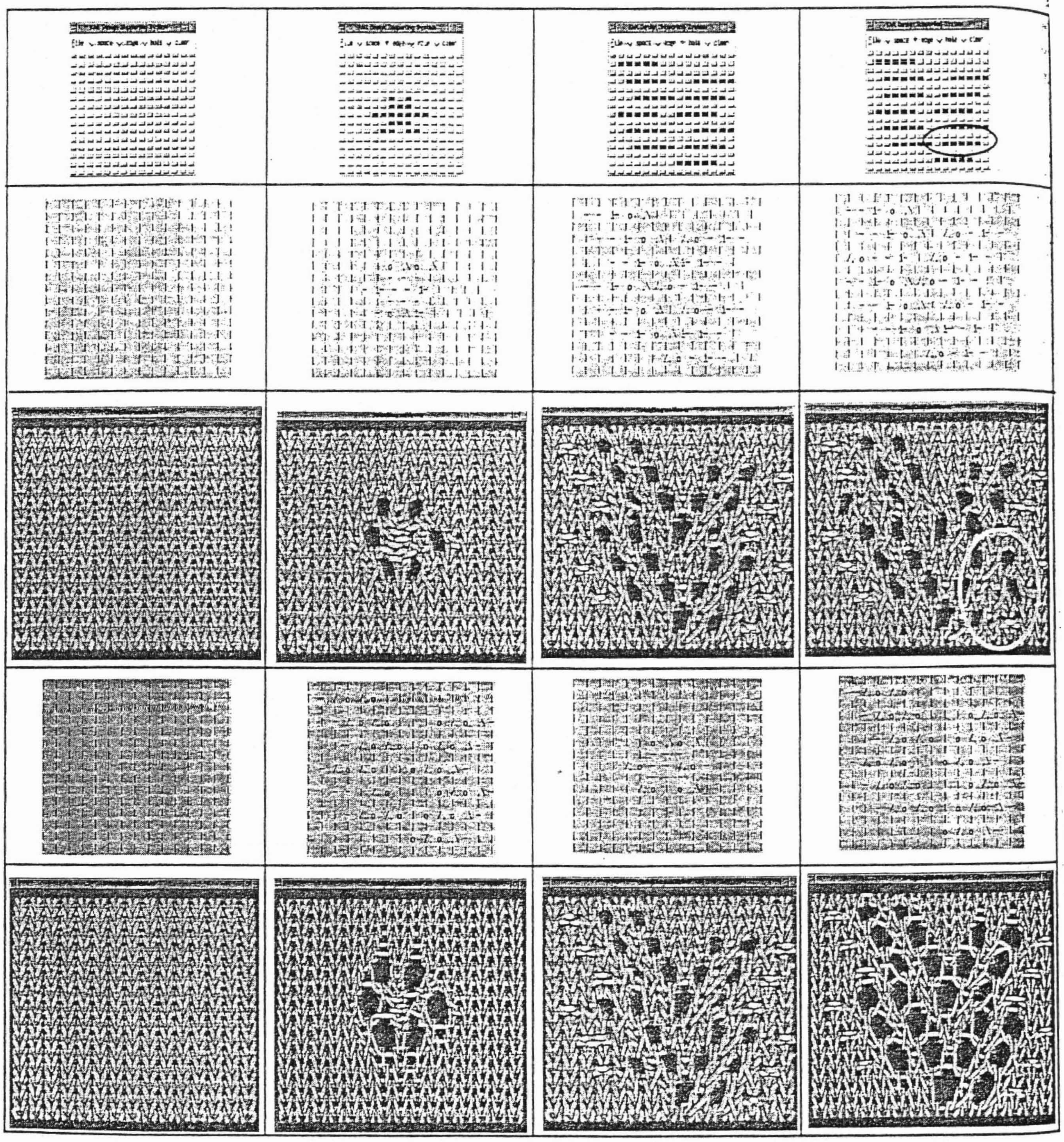

Fig.8: Running examples using algorithm 2 and algorithm 3.